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Giambattista Bello (*)

Cephalopods in the stomach contents of *Galeus melastomus* (Selachii, Scyliorhinidae) from the Adriatic Sea

Abstract – The stomach contents of 125 blackmouth catsharks, *Galeus melastomus,* from the South Adriatic Sea were examined. Cephalopods, together with bony fishes and crustaceans, play an important role in the diet of *G. melastomus.* Remains of 108 cephalopods were found and the following identified: *Heteroteuthis dispar,* Sepiolidae spp., *Abralia verany, Histioteuthis bonnellii, Histioteuthis reversa, Brachioteuthis* sp., *Todarodes sagittatus* and *Argonauta argo. H. dispar* was the predominant prey item, 76% of identified cephalopods.

Sommario – Cefalopodi nel contenuto gastrico di *Galeus melastomus* (Selachii: Scyliorhinidae) dell'Adriatico.

L'esame del contenuto gastrico di 125 esemplari di *Galeus melastomus* pescati in Adriatico ha rivelato che i cefalopodi, insieme a teleostei e crostacei, sono un elemento importante della dieta del boccanera. Sono stati ritrovati i resti di 108 cefalopodi appartenenti ai seguenti taxa: *Heteroteuthis dispar,* Sepiolidae spp., *Abralia verany, Histioteuthis bonnellii, Histioteuthis reversa, Brachioteuthis* sp., *Todarodes sagittatus* e *Argonauta argo. H. dispar* è il cefalopodo predominante (76% dei cefalopodi predati).

Key words: Cephalopoda, Selachii, *Galeus melastomus,* feeding, Adriatic Sea.

Introduction

The blackmouth catshark, *Galeus melastomus* Rafinesque, 1810 (Selachii, Scyliorhinidae), is an East Atlantic and Mediterranean benthic fish. Its habitat ranges from 200 to 1,200 m, but it is occasionally captured on the continental shelf at 55-200 m (Quéro, 1984).

Information about its feeding habits in the Mediterranean is reported by Relini Orsi & Wurtz (1975, 1977), Capapé & Zaouali (1976), Macpherson (1980), Wurtz & Vacchi (1981), and Wurtz & Palumbo (1985). They show that blackmouth catsharks feed upon bony fishes, crustaceans and cephalopods, and that the latter group makes an important portion of the prey biomass. According to Macpherson (1980), cephalopods rank second in terms of

(*) Laboratorio Provinciale di Biologia Marina - Molo Pizzoli, 70123 Bari, Italy.

biomass, following bony fishes. *G. melastomus* preys upon both benthic and midwater prey, but mostly upon the latter (Relini Orsi & Wurtz, 1975).

The main purpose of this investigation is to contribute to the knowledge of the role of cephalopods in South Adriatic food webs.

This is the first investigation on *G. melastomus* feeding habits in the Adriatic and the eastern Mediterranean.

Materials and methods

Stomach contents were removed from 125 specimens of *Galeus melastomus* captured by bottom trawling, between 180 and 630 m depth, in the South Adriatic Sea in 1985, during the «Valutazione delle Risorse Demersali» programme (research director Prof. G. Marano) funded by the Italian Ministry of Mercantile Marine (Bello *et al.,* 1988).

Catsharks ranged in total length (TL) from 22.0 to 51.4 cm.

Of the 125 catsharks, 96 were captured at dawn, 29 in full daylight. Of the same total number, 87 specimens were «juveniles» (TL $<$ 40 cm), 38 were «adults» (TL $>$ 40 cm) (*cf.* Relini Orsi & Wurtz, 1975).

Stomach contents were weighed to the closest 0.1 g soon after removal. The prey items were classified into three large taxonomic categories: bony fishes, cephalopods and crustaceans. Only cephalopod remains underwent further examination for identification to the lowest possible taxon. The following subjective digestion stage scale was used: A = early digestion; B = advanced digestion; C = only hard part remains (beaks, lenses and gladii).

Cephalopods beaks were identified using Clarke (1962, 1986) and by comparison with reference beaks removed from whole specimens (with the exception of *Brachioteuthis* sp.).

Measurements taken: dorsal mantle length (ML), lower rostral length (LRL), upper rostral length (URL), and lower hood length (LHL) (Clarke, 1986).

The coefficients of prey frequency were calculated, F_p = (number of stomachs containing prey of each taxonomic group / number of stomachs containing prey) × 100.

Mean fullness weight indices were also calculated, *FWI* = [stomach content weight / (body weight - stomach content weight)] × 100.

Results

Only 1 stomach out of 125 was empty; the vacuity coefficient is 0.8%.

The coefficients of prey frequency (Table 1) suggest a change in diet with catshark growth. Since prey size increases as well, crustacea F_p is lower for adult than juvenile catsharks, whereas the opposite is true for cephalopods and bony fishes.

The mean fullness weight index, *FWI,* is significantly higher in juvenile catshark caught early in the morning than in full daylight (Table 2), i.e. small-sized catsharks feed more during the dark than the light hours. (The mean *FWI*s for the adult component are strongly biased by a few rather high individual *FWI* values, which is also reflected by the very high variance). The fraction of cephalopods at an early digestion stage is about twice as high in the stomachs of catsharks captured at dawn compared to those captured in full daylight. This fact further supports the hypothesis of higher feeding rates during nighttime.

No differences in feeding habits were found between males and females.

Only 66 blackmouth catsharks contained cephalopod remains in their stomachs. Altogether 108 cephalopod specimens were found (Table 3). The mean number of prey-cephalopods/predator is 0.86. Seven cephalopods were unidentifiable, because represented only by lenses or rather worn out beaks.

The cephalopods are reported and commented herebelow.

Heteroteuthis dispar (Rüppell, 1844)

Remains of this species were more abundant in catsharks captured at dawn (0.69 specs./catshark) than in full daylight (0.38 specs./catshark).

Specimens at digestion stage A measured from 0.5 to 2.4 cm ML. Three of them were juveniles; the others were subadults or adults. The sex of seven specimens was ascertained: 6 of them were males (maximum ML = 2.4 cm) and 1 female, fertilized (ML = 2.0 cm).

Sepiolidae spp.

These remains were from both Sepiolinae spp. and Rossiinae spp.

Abralia verany (Rüppell, 1844)

A pair of beaks; LRL = 1.6 mm.

Table 1 — Coefficients of prey frequency, F_p. Subsample numerosity in parentheses.

Prey category	All (124)	Juveniles (86)	Adults (38)	Dawn (96)	Daylight (28)
Teleosts	77.4	73.3	86.8	82.3	60.7
Crustaceans	75.0	76.7	71.1	76.0	71.4
Cephalopods	53.2	46.5	68.4	58.3	35.7

Table 2 — Analysis of the variance of fullness-weight indices *FWI;* ns: P > 0.1.

	Dawn			Daylight			F	P
	n	FWI	Var	n	FWI	Var		
all	96	4.54	10.84	29	3.45	14.53	2.24	ns
juveniles	70	5.01	8.10	17	2.59	3.09	11.17	< 0.01
adults	26	3.27	16.54	12	4.68	29.72	1.26	ns

Table 3 — Prey-cephalopod numerosity. A = early digestion stage; B = advanced digestion stage; C = only hard part remains; total = A + B + C; % = percent calculated for fully or partially identified specimens only (n = 101); depth = depth of catshark capture.

Taxon	A	B	C	total	%	depth (m)
Heteroteuthis dispar	19	9	49	77	76.2	180-630
Sepiolidae spp.		4	10	14	13.8	320-630
Abralia verany			1	1	1.0	630
Histioteuthis bonnellii		1		1	1.0	630
Histioteuthis reversa			1	1	1.0	550
Brachioteuthis sp.			1	1	1.0	630
Todarodes sagittatus	1	1	1	3	3.0	630
unid. oegopsid squids			2	2	2.0	630
Argonauta argo			1	1	1.0	630
unidentifiable cephalopods			7	7	—	630
	20	15	73	108		

Histioteuthis bonnellii (Férussac, 1835)

Remains of a juvenile consisted of the buccal mass and four arms; LRL = 1.8 mm.

Histioteuthis reversa (Verrill, 1880)

A pair of beaks; LRL = 2.6 mm.

Brachioteuthis sp.

Only a lower beak; LRL = 2.7 mm.

The beak was fully mature (wings and lateral walls darkened), hence it belonged to an adult specimen. This beak is quite distinctive (Fig. 1). In addition to other features, it differs from all other Mediterranean teuthoid squid beaks because of the round ridge running toward the free corner of the lateral wall (Clarke, 1986). A somewhat similar ridge can be seen in the Mediterranean Enoploteuthidae squids, in which however it does not reach the corner of the wall. According to the regression equation reported by Clarke (1986), the estimated ML is 7.1 cm.

Todarodes sagittatus (Lamarck, 1798)

Fragments of a juvenile and a subadult animals, a pair of beaks from a subadult squid.

Unidentified oegopsid squids

One gladius. An upper beak; URL = 4.4 mm.

Argonauta argo Linnaeus, 1758

A pair of beaks; LHL = 4.6 mm.

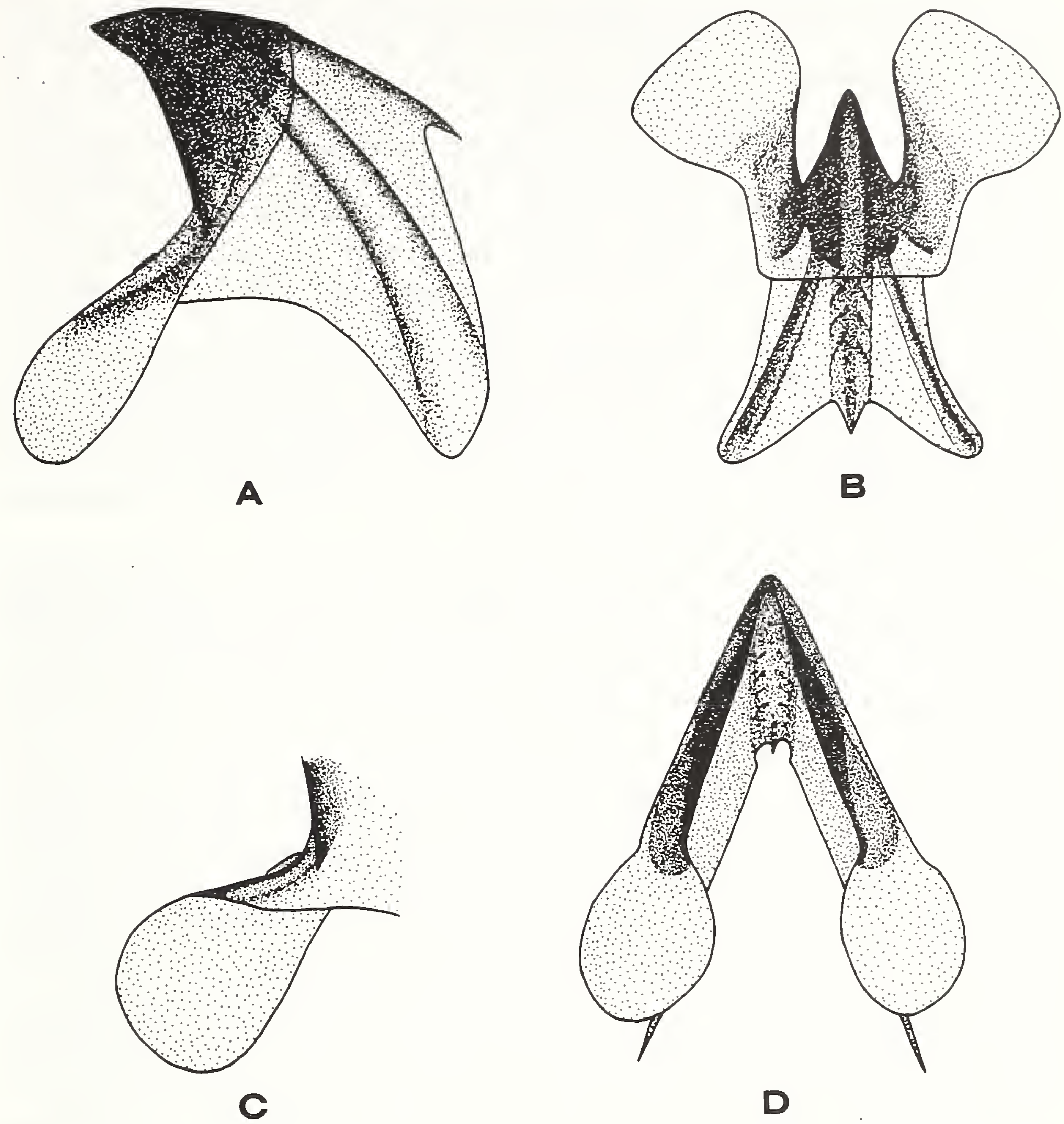

Fig. 1 – Lower beak of *Brachioteuthis* sp. Rostral length = 2.7 mm. A) Profile view. The jaw angle is obtuse, not obscured by the wing fold, which is very low. The hood is very low over the crest. There is a broad, round ridge on the lateral wall running toward the free corner. The lower edge of the lateral wall is curved. (The notch in the lateral wall to the side of the crest could be artificial, i.e. due to the digestion of light parts). B) Top view. There is no notch in the hood. The free corners of the walls are spread out. C) Medial view of the area around the jaw angle seen obliquely from below. There is a low tooth on the shoulder. The angle point is evident. D) Front view. The rostrum is narrow; $i/j = 1.6$.

Discussion

The general results about *Galeus melastomus* feeding habits – i.e. alimentary spectrum (by large taxonomic categories), change in diet with growth, feeding periodicity – are comparable with what reported by Relini Orsi & Wurtz (1975, 1977), Macpherson (1980), Wurtz & Vacchi (1981) and, in part, Capapé & Zaouali (1976).

The prey-cephalopod composition closely resembles those reported by Relini Orsi & Wurtz (1975, 1977) and Wurtz & Vacchi (1981). It differs to some extent from that of Macpherson (1980) and is quite different from Capapé & Zaouali's (1976). Macpherson's (1980) prey list does not include *Heteroteuthis dispar,* which is by far the most frequent prey-cephalopod in the Ligurian and South Adriatic Seas (see farther on). In addition Macpherson's (1980) list reports *Sepiola rondeletii,* wich according to Bello (1990) is an upper littoral species. The alimentary spectrum given by Capapé & Zaouali (1976) includes shelf and upper slope species, namely *Sepia officinalis, Sepia elegans, Sepiola rondeletii, Alloteuthis media;* they make 63% of the prey-cephalopods. Capapé & Zaouali (1976) do not report the capture depth of their blackmouth catsharks. However Capapé (*in litteris*) confirms that they were captured on bottoms from 100 to 200 m, and 400 m probably is the maximum depth, whereas the catsharks examined by all other workers were taken from bathyal grounds (Relini Orsi & Wurtz, 1975, 1977; Macpherson, 1980; Wurtz & Vacchi, 1981; this paper).

All identified cephalopods belong to oceanic species, but some unidentified ones might be benthic. However some definitively benthic prey, such as hermit crabs, were also found (data not reported in results). Relini Orsi & Wurtz (1975) suggested that blackmouth catsharks can swim toward diel migrant preys as these descend, maybe attracted by their bioluminescence. The upward swim of *G. melastomus* would be favoured by a neutral or close to neutral body buoyancy due to its large oily liver. On the contrary Macpherson (1980) believes that blackmouth catsharks possibly capture their pelagic prey close to the bottom, taking advantage of the prey vertical distribution. Wurtz & Vacchi (1981) show the occurrence of a prey selective feeding periodicity, which confirms the existence of prey-predator relative movements. In this respect, the find of a pair of female *Argonauta argo* beaks in a catshark caught at 630 m depth is quite intriguing. Argonauts are generally said to be epipelagic animals (Voss, 1967; Mangold & Boletzky, 1987). The depth of the fatal encounter between the predator-catshark and the prey-argonaut remains a matter of conjecture. Most probably it occurred in midwater, far below the surface as well as above the bottom, in agreement with the aforementioned hypothesis by Relini Orsi & Wurtz (1975).

Heteroteuthis dispar is the most common food item for *G. melastomus* in the South Adriatic (76% of cephalopods) as well as in the Ligurian Sea (87%, Relini Orsi & Wurtz, 1977; 79%, Wurtz & Vacchi, 1981). This small sepiolid squid appears to be a keystone element in several marine food webs (Wurtz & Palumbo, 1985). According to the present results and to Wurtz & Vacchi (1981), blackmouth catsharks feed upon *H. dispar* during the dark hours, just when this cephalopod should be in the upper part of its distributional range (Roper, 1974). Indeed, the vertical movements pattern of *H. dispar* appears to be rather complex, in that changes occur during its life cycle (Orsi Relini, in press). Relini Orsi & Wurtz (1975) suspect that *G. melastomus* is attracted by bioluminescent prey, which would explain its preference for *H. dispar.* Further reflections on the relationship between *H. dispar* and demersal selachians are reported in Bello (in press).

The lower beak ascribed to *Brachioteuthis* sp. possibly derived from a specimen of *Brachioteuthis riisei* (Steenstrup, 1882), the only known Mediterranean and adjacent Atlantic Ocean species of the genus (Bello, 1986; Mangold & Boletzky, 1987, 1988; Guerra, 1992).

The examination of *G. melastomus* stomach contents also contributed to the knowledge of the Adriatic teuthofauna. The presence of *H. dispar* in the Adriatic was first recorded thanks to specimens found in the stomachs of catsharks and swordfish (Bello, 1990). The find of remains of *A. verany, H. bonnellii, H. reversa* and *Brachioteuthis* cf. *riisei* represents the second occurrence of such species in the Adriatic (see Bello [1990] on their first record).

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